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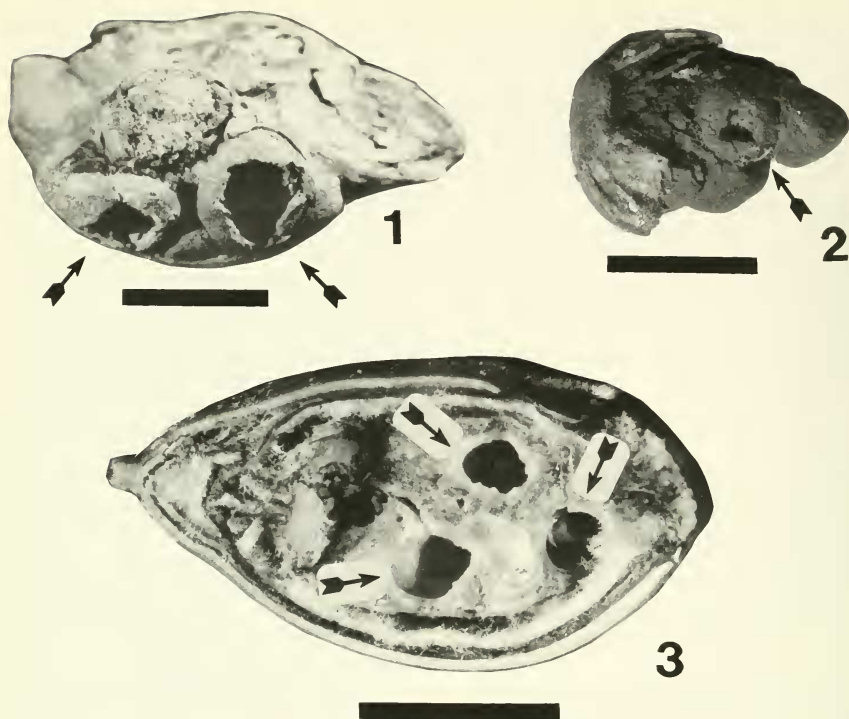
Two Cynipid Wasp Acorn Galls Preserved in the
La Brea Tar Pits (Early Holocene)

Published accounts of fossil plant galls have been derived almost exclusively from studies of leaf impressions (Larew. 1986. Proc. Entomol. Soc. Wash. 88: 358-388), and gall structure is rarely preserved. This report describes pieces of two acorns taken from the Rancho La Brea Tar Pits, Los Angeles, California, USA that have been galled and preserved intact.

While studying the fossil seeds of the Rancho La Brea Tar Pits, Templeton (Unpublished Ph.D. dissertation, 1964, Oregon St. Univ., Corvallis, 224 pp.) identified several acorns removed from the tar matrix in excavated sabre-toothed cat (*Smilodon*) skulls. The specimens were excavated between 1913 and 1929. One specimen is described as a "fossil acorn of *Quercus agrifolia* showing insect infestation" (*ibid.*, Fig. 34). This acorn (specimen number 1481, Templeton Collection, G. C. Page Museum, Los Angeles, California) was excavated from Pit A at Rancho La Brea. Based on carbon dating of wood found in Pit 3, Templeton estimated the age of the plant remains at La Brea as 13,000-15,000 years (early Holocene). The specimen label states "LACM Paleobotany Plesiotype No. PB 1481." I found another similarly damaged acorn in the Templeton Collection (specimen number 1418B) that was removed from a sabre-toothed cat skull in Pit 3 and is from an undetermined species of oak. Both specimens had been cleaned of tar with kerosene and xylol so that external features were evident. To study affinities with extant specimens, comparisons were made with galled acorns from the L. H. Weld cynipid collections (California Academy of Sciences, San Francisco, California and the Museum of Natural History, Smithsonian Institution, Washington, D.C.).

Specimen 1481 consists of cotyledon tissue (1.6 cm long, 1.0 cm wide) (Fig. 1) and detached remnants of the inner surface of the seed coat. The cotyledon tissue is dark brown and woody in texture. An acorn cup is not present. The outer surface of the cotyledons bears 10 blister-like swellings on average 4.5 mm in diameter. The outer surface of many of the swellings has been chewed through or worn away so that an empty internal cavity is exposed (1.5 mm deep). Specimen 1418B (Fig. 2) is smaller (0.9 cm long, 0.6 cm wide) and consists of a dark brown remnant of core cotyledon tissue capped by what is most likely the smooth, cup-shaped remains of cotyledon tissue preserved under the acorn cup. The cup is not present. The cotyledons bear two swellings (3 mm in diameter) each of which contains an empty central cavity.

Comparison with extant acorn galls caused by several species of cynipids reveals that the La Brea galls resemble those caused by *Callirhytis milleri* Weld (Fig. 3) which galls acorns of *Quercus agrifolia* Nee, *Q. wislizenii* A. de Cand., and *Q. californica* Cooper (= *Q. kelloggii* Newberry) in California (Weld, 1922. Proc. U.S. Nat. Mus., No. 2440. 61(19): 1-32). Weld (*ibid.*) described the damage caused by this wasp as a "compact stony-hard mass containing four to a score or more confluent cells (chambers) . . . more or less filling the interior of the acorn, which is frequently reduced in size. The woody mass thus occupies the center of the acorn . . . , extends its whole length, and when the acorn is cut open can be lifted out intact." It is this woody mass that has been preserved in the La Brea specimens. The swellings are cells in which the larval and later, pupal cynipid lived (one/cell). Adults emerging from the cells most likely chewed



Figs. 1-3. Acorn galls. Scale line = 5 mm. 1, Specimen 1481; preserved galled acorn of *Quercus agrifolia*. Opened swellings (arrows) on the surface of disrupted cotyledonous tissue are larval/pupal cells. 2, Specimen 1418B; preserved galled acorn, unknown oak. Larval cell (arrow) showing presumed exit hole is evident. 3, Modern-day acorns of *Q. wislizenii* galled by *Callirhytis milleri*. Cut-away view of clumped larval cells (arrows) forming woody mass inside seedcoat.

exit holes in the outer cell wall thus exposing the internal cavity as seen in the preserved specimens. One swelling on specimen 1481 shows a very small, circular hole in the outer wall suggestive of a parasite's exit hole. Emergence of adult *C. milleri* occurs in March and April (Weld, *ibid.*). Thus the La Brea galls appear to be of a mature stage and were most likely preserved after abscission and after the adult gall formers emerged.

Very few Quaternary fossil galls have been described (Larew, *ibid.*). All available Ho-

locene specimens are cynipid-caused oak galls such as leaf galls collected at a pre-Roman Iron Age hill fort in Sussex, England (Cunliffe, 1976. Council for British Archaeology, Res. Rept. 16, London), oak root galls at Chew Valley Lake, probably from a Roman well, Somerset, England (Eady, 1977. Dept. Environment, Archaeological Reports, London. p. 373), or leaf galls in moss between stones lining a 4th century Roman well in Oxon, England (Robinson, 1980. *J. Archaeological Sci.* 7: 93-95). Oak galls preserved at Herculaneum by the erup-

tion of Mount Vesuvius (A.D. 79) were most likely items of commerce (Larew, 1987, *Econ. Bot.* 41: 33–40). The La Brea specimens enrich the fossil gall record by virtue of their being the first Holocene galls collected outside of Europe, and the first fossil acorn galls ever collected. They provide the first tangible evidence that recognizable galls of seeds were being produced several thousand years ago, possibly by an extant wasp species.

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